

APPLICATION  
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TITLE: HETEROGENEOUS NETWORK FILE ACCESS

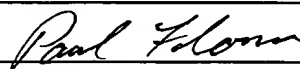
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"EXPRESS MAIL" Mailing Label Number TB 888 891 498 US

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HETEROGENEOUS NETWORK FILE ACCESS

BACKGROUND

The present invention relates generally to electronic communications.

5           During communication sessions in data networks, clients typically request information provided by servers.

Increasingly, clients seek information located on different servers, coupled to networks having different data encoding and file transport protocols. For example, a user in an  
10           organization using one computer (e.g., a windows-based machine), might seek to access data on another windows-based machine coupled to a local area network (LAN) running Novell NetWare, as well as data on a Unix-based machine, located on a LAN running Unix/NFS (Network File System), as well as  
15           data residing on an Apple Macintosh machine, located on a LAN running AppleTalk.

One method for allowing such access requires development of a software application which both connects the two machines (the local client and the destination  
20           server) as well performs all the translations in both data encoding and file transport at both ends of the communication link. Such a program, installed and running at both ends of the communication link, can translate the client's network protocols into the proper file access  
25           protocols for the server's network, and then retrieve the desired file, while translating the file's data from its

original format into a format usable by the client. Each such connection between different types of client and server environments typically requires separate network and data translation schemes. In addition, such software applications must typically reside at the network layer 3, and be installed into the kernel of the operating system of both the client and the server. Therefore, for a number of clients to communicate with a given server, such translation/communication applications typically requires configuration and installation into each client's operating system.

"Tunneling" typically allows redirection of network drives, where a file received in one network protocol (e.g., NFS, Windows Networking (SMB) is typically encrypted within another layer of redirection (the "tunnel"). Generally, tunneling is also implemented at the operating system kernel and is platform specific.

Web browsers can be used to initiate file transfers (e.g., with an "ftp://<url>" nomenclature), but this only allows file transfers from a machine residing on the Internet.

#### SUMMARY

In general, in one aspect, the invention features a method for a client to access data files residing on a first data server through a network, the method including coupling a heterogenous proxy server to the first data server through

a first local network protocol, receiving at the heterogeneous proxy server a data file from the first data server by employing the first network protocol, translating the data file into a format compatible with transmission through the network, and transmitting the translated data file to the client across the network.

Embodiments of the invention may include one or more of the following features. A request can be sent from the client to the heterogeneous proxy server that the data file be received from the first data server and then sent to the client. The heterogeneous proxy server can be coupled to a second data server through a second local network protocol, the first and second local network protocols being different, and the heterogeneous proxy server can selectively receive a data file from at least one of the first or the second data servers by employing the respective first or second local network protocols, can translate the data file into a format compatible with transmission through the network, and transmit the translated data file to the client across the network. The network can employ Transmission Control Protocol (TCP). The format compatible with transmission through the network can be HyperText Transport Protocol (HTTP). The format compatible with transmission through the network can be a Multipurpose Internet Mail Extension (MIME) of HTTP. The first and second local network protocols can each comprise one of the

following: Windows Networking (SMB), File Transport Protocol (FTP), Network File System (NFS), IPX/NCP (Novell Core Protocol), Banyan VINES, DECNet, and AppleTalk. The client can employ an HTTP browser for connecting to the

5 heterogeneous proxy server. File management and downloading services can be accomplished using an HTML document (or web page) containing information from the heterogeneous proxy server regarding available data files on data servers and providing the client with appropriate selections, including

10 allowing the client to send a request for the data file to the heterogeneous proxy server. Or the client can download

an applet executable by the HTTP browser, the applet being configured to receive information from the heterogeneous

15 proxy server regarding available data files on the data servers, and to send a request for the data file to the heterogeneous proxy server. The applet, upon receiving the data file, can initiate an appropriate application for using the data file. The data file can be compressed at the heterogeneous proxy server before the data file is

20 transmitted to the client. The data file can be e-mailed from the heterogeneous proxy server to an e-mail recipient, without transmitting the data file to the client. The heterogeneous proxy server can search for the data file at one or more data servers. The client can be authenticated  
25 before connecting the client to the heterogeneous proxy server.

In general, in another aspect, the invention features a method for a client to access data files residing on at least a first and a second data server through a network, wherein the network employs Transport Control Protocol (TCP), the method including coupling a heterogenous proxy server to the first data server through a first local network protocol, and to the second data server through a second local network protocol, the first and second local network protocols being different, sending a request from the client to the heterogeneous proxy server that the data file be received from the first or second data servers and then sent to the client, wherein the client employs an HTTP browser for connecting to the heterogeneous proxy server, selectively receiving at the heterogeneous proxy server a data file from at least one of the first or the second data servers by employing the respective first or second local network protocols, translating the data file into a format compatible with transmission through the network, comprising HyperText Transport Protocol (HTTP), and transmitting the translated data file to the client across the network.

In general, in another aspect, the invention features a storage device tangibly storing a control program, the control program, when coupled to a control device, operating the control device to allow a client to access data files residing on a first data server through a network, the control program being configured to operate the control

device to perform the functions of coupling a heterogenous proxy server to the first data server through a first local network protocol, selectively receiving at the heterogeneous proxy server a data file from the first data server by  
5 employing the respective first local network protocols, translating the data file into a format compatible with transmission through the network, and transmitting the translated data file to the client across the network.

Advantages of the invention may include one or more of  
10 the following. A number of clients can connect to a heterogeneous proxy server and gain access to files located on a number of different network platforms. A client can use a common web browser to connect to the heterogeneous proxy server without special software in order to gain such  
15 access. Moreover, heterogeneous clients using different computer platforms (such as PCS, Unix machines or Macintoshes) can access data on any number of different servers, if the heterogeneous proxy server has an appropriate protocol interpreter. No special translation  
20 software is required at either the client or the target server having a desired file -- all translation occurs at the heterogeneous proxy server. Each user can seamlessly and transparently retrieve a file, regardless of its native network format or location, remotely retrieve it across the  
25 Internet, and have their local web browser automatically detect the type of file retrieved, load an appropriate

application, and then display the file to the user. Upon completing operations with the file, the user can close and save it, and the web browser can be configured to send the file back to a destination data server (which can be different from the original source data server), and the file, before further transmission and storage at the destination, can be retranslated by the heterogeneous proxy server into the network format native to the destination.

Calculation and time intensive operations upon files (such as compression and searching) can be conducted by the heterogeneous proxy server, leaving relatively lower bandwidth operations (such as list and file transfers) to the connection between client and heterogeneous proxy server. Network traffic between client and heterogeneous proxy server can be automatically encrypted by SSL using HTTP/S, incorporated in newer web browser applications, and compressed by any compression schemes easily decoded via a browser or associated helper applications. An administrative application can be coupled or embodied in a heterogeneous proxy application in order to capture, record, and tabulate operations such as user accesses and server and file accesses. The administrative application can thereby keep a detailed logging and accounting of this usage data for security monitoring and capacity planning. Furthermore, a detailed logging of all Internet-based remote accesses can simplify such data collection, as opposed to recording and



retrieving such data at each separate network data server being accessed.

These and other features and advantages of the present invention will become more apparent from the following description, drawings, and claims.

#### DRAWINGS

Figure 1 is a schematic diagram of a network providing a heterogeneous proxy server and application.

Figure 2 is a functional block diagram of a heterogeneous proxy application.

Figures 3a through 3h are flow charts illustrating the operation of a heterogeneous proxy application.

Figure 4 is a heterogeneous proxy application stored on a machine-readable device.

#### DESCRIPTION

As shown in Figure 1, a client 10 connects across a network 12 to a heterogeneous proxy server system 14, initially through a public server 16. In a preferred embodiment, network 12 is an IP-compliant network (e.g., the Internet), and client 10 connects to public server 16 via HTTP using a "web" browser 20. However, the methods and apparatus described below can be used within other networks 12, using other network protocols and communication applications.

An access applet 22 can be downloaded from public server 16 and executed at client 10. The applet can be an

ActiveX or Java-based access applet 22 executed by browser  
20. Access applet 22, in conjunction with public server 16,  
can perform optional authentication procedures upon client  
10, which, if successful, connect client 10 to secure server  
5 24. Alternatively, instead of a downloaded access applet, a  
user interface for performing functions with heterogeneous  
proxy server system 14 can be provided by other front end  
applications at the heterogeneous proxy server system 14.  
For example, an HTML web page sent by either public server  
10 16 or private server 24 to client 10 can allow for user  
selection of any or all of the functions described below,  
without downloading any higher level software.

Heterogeneous proxy application 26, running on secure  
server 24, can connect client 10 with data files residing on  
15 one or more data servers 28a, 28b, and 28c coupled to one or  
more different networks 30a, 30b, and 30c. For example,  
first data server 28a can be coupled to secure server 24 via  
a Windows NT network 30a, while second data server 28b can  
be coupled to secure server 24 via a Novell NetWare  
20 network 30b, and while third data server 28c can be coupled  
to secure server 24 via a Unix/NFS network 30c.

Heterogeneous proxy application 26 uses one or more  
protocol interpreters 32a, 32b, and 32c to communicate with  
respective data servers 28a, 28b, and 28c on respective  
25 networks 30a, 30b, and 30c. Protocol interpreters 32a, 32b,  
and 32c can reside within heterogeneous proxy

application 26, or be separate modules accessible by heterogeneous proxy application. These protocol interpreters 32 may be installed into the kernel of the secure server 24 (or more generally any server machine which is part of heterogeneous proxy server 14). Protocol interpreters 32 provide networked access to files. In some cases protocol interpreters 32 can implement high-level file transfer protocols (e.g. FTP) and in other cases implement kernel-based drive/directory redirection protocols (e.g. NFS or Novell/IPX/NCP).

As shown in Figure 2, heterogeneous proxy application 26 includes a download file module 34, an upload file module 36, a compress file module 38, a search file module 40, a mail file module 42, and a create directory module 44. Download file module 34 enables client 10 to select and retrieve a file from a selected data server 28 on a network 30, through network 12, to the client 10. Upload file module 36 allows a reverse operation: client 10 can transfer a file from itself through network 12 to a selected data server 28 on a respective network 30.

Compress file module 38 allows heterogeneous proxy server 14 to compress a selected file locally before further operations (such as downloading or e-mailing). Search file module 40 allows client 10 to search directories on one or more of the supported, attached data servers 28 in order to find and select a file. Mail file module 42 allows a client

to e-mail a selected file directly from heterogeneous proxy server system 14, without first downloading the file to client 10 and then e-mailing it. Create directory module 44 allows a client 10 to create a file directory on any of the supported, attached data servers 28 in order to store one or more files.

As shown in Figures 3a through 3h, a heterogeneous proxy server method 100 typically begins with client 10 connecting to public server 16 via web browser 20 (step 102). Client 10 can access a user interface web page, download access applet 22 at this time, have access applet 22 already preinstalled, or can download access applet 22 after being properly authenticated as a legitimate client (step 104). For example, traveling employees could simply connect to their company's public web page, log onto a file access web page, or download access applet 22, and begin an authentication and file retrieval session, without requiring anything but a readily available web browser, and without making any changes to the operating system of client 10.

Once client 10 is properly authenticated, it is connected to secure server 24 (step 106). Secure server 24 can then initiate additional access control methods (step 108). One example of such methods is given in co-pending application serial number 08/928,360, filed September 12, 1997, entitled "Remote Access-Controlled Communication", incorporated herein by reference. Such methods can provide

further levels of secure access for external clients 10 to sensitive data residing on secure server 24 and data servers 28.

Once client 10 has the requisite access, secure  
5 server 24 builds and transmits to client 10 a list of available data servers 28 coupled to secure server 24 (step 110). The list can be compiled from, e.g., a local host file, a DNS server for TCP/IP data server hosts, from a Windows Name Server for data servers 28 coupled through a  
10 Windows Networking protocol, from a Novell NDS or Novell Bindery for data servers coupled through NetWare, or through comparable processes or data structures for DECNET or Banyan VINES-based servers. This list can be built and stored in advance, rather than be constructed on the fly, although  
15 pre-built lists can yield errors when, e.g., a data server is no longer connected due to a network fault. Access applet 22 can present to client 10 the built list of available data servers 28, preferably in a convenient form, such as a typical graphical interface file manager window.

20 One method for building a list of available data servers 28 begins by querying the local public server 16 and secure server 24 (e.g., primary domain controller and the local domain-name servers) to list all hosts that are in the current domain. Also, each connected Windows name server  
25 can be queried for all known Windows-based hosts along with the respective workgroups. Further, each Novell bindery or

NDS tree can be queried for all respective Novell hosts.

Other data servers coupled through other network protocols can be queried similarly. Each of the results of these queries are stored in a local host file accessible by

5 heterogeneous proxy application 26, which can sort the list and remove any duplicates.

Once client 10 receives the list of available servers, the user of client 10 can select a given server and provide a given action (step 112). For example, client 10 can,

10 again through a GUI, allow a user to mouse click a given icon for a data server 28, indicating that the user would like to open that data server 28 and browse its directory and file contents. The access applet 22 can optionally  
15 require an additional password at this (or any other) point to grant the user access to the selected resource. Another option is that the user can query the secure server for a list of available network resources.

Upon receipt of the client request, secure server 24 attempts to connect to the requested data server 28 (step  
20 114). Connections are made through respective network protocol interpreters 32. Thus, secure server 24 appears to a respective data server 28 as a fully compatible network peer. For instance, if data on a Unix/NFS data server 28b is desired, second protocol interpreter 32b is employed to  
25 control transfer of data to and from second data server 28b, and cause secure server 24 to appear like a Unix/NFS client

to data server 28b. If the connection attempt fails for any reason, control returns to step 110 and secure server 24 attempts to build a new correct list of available data servers and an appropriate message is transferred across network 12 (e.g., using HTTP) to client 10 that the selected resource is unavailable.

If the connection is successful, client 10 receives a listing of contents of the selected data server 28, e.g., in a graphical interface file manager type list of directories and files (step 116 (this step is also referred to as "Menu" for recursive returns during method 100)). Access applet 22 can handle all such displays of information, and can capture user requests at client 10. The user of client 10, referring to the displayed contents of data server 28, can make further requests and take further actions, e.g., through mouse clicks and keyboard data entry. Such requests are transferred over network 12 and accepted by heterogeneous proxy application 26 on secure server 24 (step 118).

If the accepted request is to open a displayed folder (step 120), control then returns Menu (step 116), and heterogeneous proxy application 26 descends one level down the folder hierarchy of the current data server 28, generates a new list of folders and files, and then sends this new list over network 12 to client 10 for display to the user.

If the accepted request is to open a displayed file (step 122), control transfers to the download file module 34 (Go to A in Figure 3b, step 124). First, the requested file is retrieved from, e.g., data server 28a via the appropriate protocol interpreter 32a over respective network 30a (step 134). Second, the file type, e.g., text, gif, jpeg, or other is determined (step 136). Third, an appropriate Multipurpose Internet Mail Extension (MIME) type and subtype are calculated from the file type, in order to send the file to client 10 over network 12 as an e-mailed file with an appropriate content type. If the file is simply ASCII or text (including program source code), it can be sent as content/type = "text/plain". If the file is an image file (JPEG, GIF, etc.), then it can be sent as "image/<image type>". If the file type is "other", the file extension of the file is used to look up a corresponding MIME type for that extension, and the file can be sent with information specifying application/file extension information. That is, if no MIME type is found, then the file is sent as "application/<extension>". If there is no file extension, the file can be sent in a customizable mime type configuration as "application/octet-stream". The file is then sent via network 12 to browser 20 at client 10 (step 140), and operation returns to Menu (step 142).

As an example, client 10 can be a Macintosh computer employing a Macintosh-compatible web browser such as



Netscape Navigator, and can be requesting a Microsoft Word document having a file extension ".doc" located on a Windows NT data server 28. Heterogeneous proxy application 28 retrieves the Word file using a Windows NT protocol

5 interpreter 32 across the Windows NT network, determines that it is a Word text document having a ".doc" file extension, and transmits a proper MIME file via HTTP over network 12 (the Internet) to client 10. Upon receipt of the file, web browser 20 (or access applet 22) automatically

10 translates the MIME document into a proper Macintosh-formatted Word file (since web browser 20 has already been configured to handle Macintosh files), and opens the Word file using a Macintosh-compliant Word Program (if available). This depends upon transferring the file with

15 the proper MIME type and subtype so that browser 20 can open it properly. All of these activities appear seamless to the user of client 10.

If the client request is a file processing command (or a "High IQ" command) (step 126), control transfers (Go to B in Figure 3c, step 128) to one of several commands. If the

20 client request is a compress file command (step 144), then control passes to the compress file module 38 (go to D in Figure 3d, step 146) and a selected file is retrieved from the selected data server 28 as set forth above (step 156).

25 Heterogeneous proxy application 26 then compresses the file (step 158), and the file is then stored (e.g., locally at

the secure server 24, on the original data server 28, or  
elsewhere) with a new name (step 160). Storing the  
compressed file allows for retransmission of the compressed  
file should communication with either client 10 or an e-mail  
5 destination fail. Once compression is complete, control  
returns to Menu (step 162).

If the client request is a mail file command (step  
148), then control passes to the mail file module 42 (Go to  
E in Figure 3e, step 150) and a selected file is retrieved  
10 from the selected data server 28 as set forth above (step  
164). Heterogeneous proxy application 26 then prompts  
client 10 for a destination to e-mail the file (step 166),  
and determines the file type (step 168). Depending upon  
file type, the file is sent by invoking a Mailer routine to  
15 send the file to a requested destination with the proper  
file type (step 170). For example, if the file is simple  
ASCII, then it can be sent as an e-mail text file in the  
main body of the e-mail message. If it is binary, then the  
file can be encoded using Base64, made into an e-mail  
20 attachment, the user can be queried for proper addressees  
(including, e.g., any cc's, or bcc's, reply to, and other  
header fields), and then the properly addressed file can be  
sent. Once the file has been sent, control returns to Menu  
(step 172). Compression and mailing of a selected file can  
25 optionally be combined into a single command, such as

"compress and send", which would combine the two sets of procedures.

If the client request is a search for file command (step 152), then control passes to the search file module 40 (Go to F in Figure 3f, step 154) and client 10 is prompted for conventional search criteria such as text strings, wild cards, and/or boolean operations (step 174). Directories on a selected data server (or servers) are recursively searched to locate all matching files (step 176). This searching is conducted through commands from heterogeneous proxy application, translated and mediated by one or more of the appropriate protocol interpreters 32. Results of the search are compiled and then relayed via HTTP across network 12 for display to the user of client 10 (step 178). Again, control returns to Menu (step 180).

Referring again to Figure 3a, if the client request is to upload a file from client 10 to a selected data server 28 (step 130), then control passes to the upload file module 36 (Go to C in Figure 3g, step 132) and heterogeneous proxy application 26 receives the data file from client 10 via HTTP across network 10 (step 182). The received file is decoded based upon its encoding type (step 184). That is, Macintosh files are decoded from Binhex, Windows 95 files are decoded from Base64, and Unix files are decoded from Uuencode. Then, the appropriate protocol interpreter 32 is invoked to transfer the uploaded and decoded file to a

selected folder and filename on the respective selected data server 28 (step 186), where the file is then appropriately stored (step 188). At the conclusion of the file upload procedure, control again returns to Menu (step 190).

5 Referring again to Figure 3a, if the client request is to create a directory at a selected data server 28 (step 131), then control passes to the create directory module 44 (Go to G in Figure 3h, step 133) and heterogeneous proxy application 26 receives the server and directory information from client 10 via HTTP across network 10 (step 192). The received information is then used to create the appropriate directory at the selected data server 28 using the appropriate protocol interpreter 32 (step 194). At the conclusion of the create directory procedure, control again returns to Menu (step 196).

15 Referring to Figure 4, computer program 210 (comprising executable instructions) can be placed upon any machine-readable device 200, such as a floppy disk, CD-ROM, removable hard drive, or other memory device, and can then be loaded into secure server 24. Computer program 210 can include instructions which, when loaded into secure server 24 (or any other servers, including public server 16), provides the application software needed to generate an appropriate heterogeneous proxy application 26 to provide a heterogeneous proxy system 14.

Other embodiments are within the scope of the claims.

For example, the network 12 can be any electronic

communication medium. Client 10 and heterogeneous proxy

server system 14 can use any available electronic

5 communication protocol and interfaces. Data servers 28 can

be connected to heterogeneous proxy server system 14 through

any available network protocol or system, including wireless

radio and infrared networks. Any software applications at

the client and server can be implemented in software code

10 executed by one or more general purpose computers, in

firmware, or in special-purpose hardware. Heterogeneous

proxy application can include one or more of the specific

modules 34 through 44 described above, and other modules for

performing additional functions with data files received

15 from a data server 28.

What is claimed is: